Space Weather Technical Forecast

Issued on Tuesday, 07 March 2023 at 00:12 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: M-class flares (R1-R2/Minor-Moderate radio blackouts) likely throughout with a slight of X-class flares. Chance of G1/Minor Storm intervals especially between 07 to 08 Mar. Electron fluence is expected to be Active.
Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate through the last 24 hours with four M-class flares. The two largest were from AR3243, peaking at M5.8 at 06/0228UTC. A rmore recent M1.0 originated from 3242 at 06/1750UTC, and an M1.3 at 06/0913UTC from close to the southwest limb, which also produced a CME.

There are eleven sunspot regions on the visible disc, with the most dominant region AR3242 in the northeast quadrant. This has a delta region in the centre of the group and continues to evolve. AR3245 is also evolving close to the southeast limb with further growth observed. AR3243 also retains complexity as it approaches the northwest limb, but the viewing angle is making detailed analysis increasingly difficult. The remaining regions are all relatively simple or evolving slowly.

No Earth directed CMEs were observed in available imagery. A CME observed leaving the southwest limb early on 6 Mar, has now been analysed with model results showing a clear miss.

Solar Wind / Geomagnetic Activity: The solar wind as observed at L1 by DSCOVR, has varied between elevated and strong levels, reaching a peaks of 630km/s, with a slow overall decrease since around 06/0900UTC. Density has been around average throughout. Total magnetic field strength was weak at close to 6nT, with the north-south component varying weakly between positive and negative directions. Phi angle was primarily negative (towards the Sun). Geomagnetic activity was Quiet to Active (Kp 2 to 4).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16 remained at background levels. Electron flux at GOES16 has been high with a peak of 3790pfu at 06/1615 UTC. Electron fluence has been above the Active threshold (1e8 integrated flux) during the period, with a value of 1.63e8 integrated pfu recorded at 07/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to be mainly Low to Moderate, due to the presence of a number of significant sunspot regions across the disc. There is a risk of Strong activity due to the complexity of two regions, AR3243 on the northwest limb and AR3242 in the northeast quadrant.

Solar Wind / Geomagnetic Activity: No significant Earth-directed CMEs feature in the current forecast, with only a glancing blow possible between 07 to 08 Mar. A current coronal hole high speed stream is expected to wane through 07 Mar, with a further high speed stream possibly connecting on 08 Mar. Geomagnetic activity is expected to be mainly Quiet to Unsettled, with a risk of Active to G1/Minor storm intervals due mainly to any possible CME glance. There is also

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a risk of G1/Minor Storm intervals on 08 Mar due to a high speed stream connection.

Energetic Particles / Solar Radiation: High energy (greater than 10MeV) proton flux, as observed by GOES16, is currently at background levels, but with a slight chance of reaching S1 or greater should any larger flares occur. Electron flux is likely to continue at high levels but with uncertainty due to the low chance of a CME glancing blow and a coronal hole high speed stream connection potentially suppressing levels. Electron fluence is above the Active (1e8 integrated pfu) threshold, and is likely to remain above Active levels through the guidance period albeit with some uncertainty.

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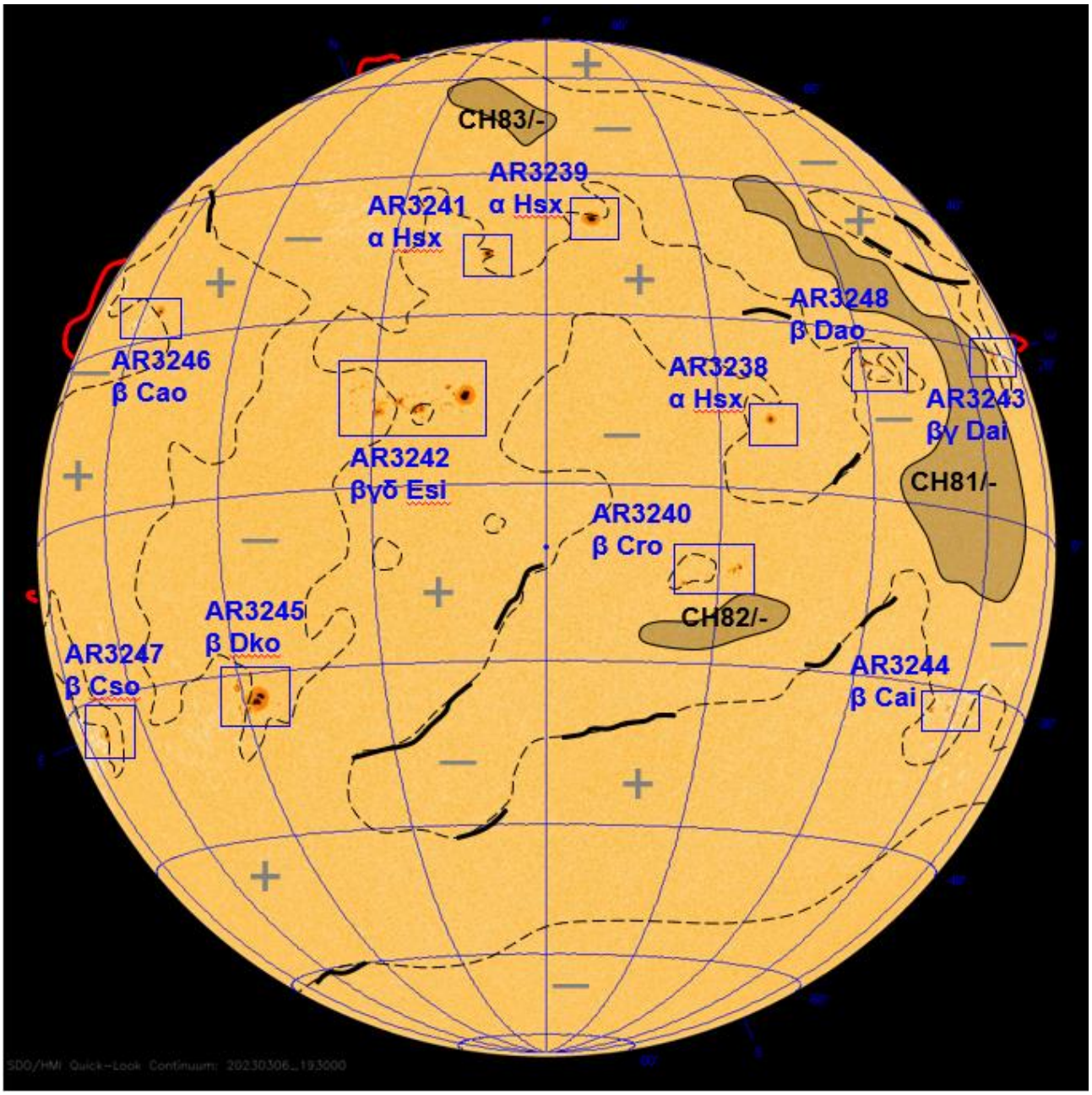
Figure 1. Solar Analysis Valid 06/2000UTC.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There is one possible glancing CME forecast through the next four days. but with low confidence. This was a CME which left the Sun on 05 Mar, which could just glance the Earth on either 07 or 08 Mar, however it is more likely to miss ahead of the Earth orbit. A further CME observed leaving the southwest limb early on 6 Mar, has now been analysed with model results showing a clear miss.

Earth is continuing under the influence of a high speed stream from large coronal hole 81 which is now close to the western limb. The high speed stream is expected to wane through 07 Mar, but elevated winds are possible during the period due to the smaller coronal hole 82 which is just transiting centre disc and could connect on 08 Mar. As the Earth is approaching the March equinox, negative polarity coronal holes such as 81 and 82 are favoured for providing a strong geomagnetic response.

Geomagnetic activity is expected to be Quiet to Unsettled throughout the period, with a risk of Active or G1/Minor Storm intervals due to any significant CME effects or due to the connection of a coronal hole high speed stream from coronal hole 82.

Geo-Magnetic Storm / Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	20	10	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

None expected.

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Radio Blackouts - X-Ray Flares:

There are eleven sunspots on the visible disc, with AR3242 in the northeast quadrant, the largest region with the highest risk of flares. This region has a delta spot in the centre of the group and continues to evolve.The most active region on the disc is AR3243 close to the northwest limb, which has produced two flares in excess of the M5 level and contributes significantly to the overall flare risk. The remaining regions are all relatively inactive, but AR3245 has shown modest signs of increasing complexity. The rotation of complex regions across the western limb through the period is likely to be balanced by further possible returning regions rotating onto the east limb, with risks kept relatively stable through the period.
Solar activity is forecast to be mainly Low to Moderate, with a risk of isolated X-class flares throughout.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	70	70	70	70
Very Active	R3 to R5 X Class	No	10	10	10	10

Solar Radiation Storms - (High Energy Protons):

High energy (greater than 10MeV) proton flux, as observed by GOES16, is currently at background levels. AR3234 is now over the west limb, and will contribute a declining portion to the risk of S1 or greater events occurring into 07 Mar. Meanwhile, AR3242 will be rotating towards centre disc posing an increased risk of proton flux increasing with any larger flares, especially given the delta configuration. AR3243, nearing the northwest limb, was also responsible for two flares in excess of M5 level, so this is now contributing a small amount to the risk of a proton event. Overall, the probabilities have been kept flat through the period with AR3242 taking over from AR3243 as the main risk area.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	10	10	10	10
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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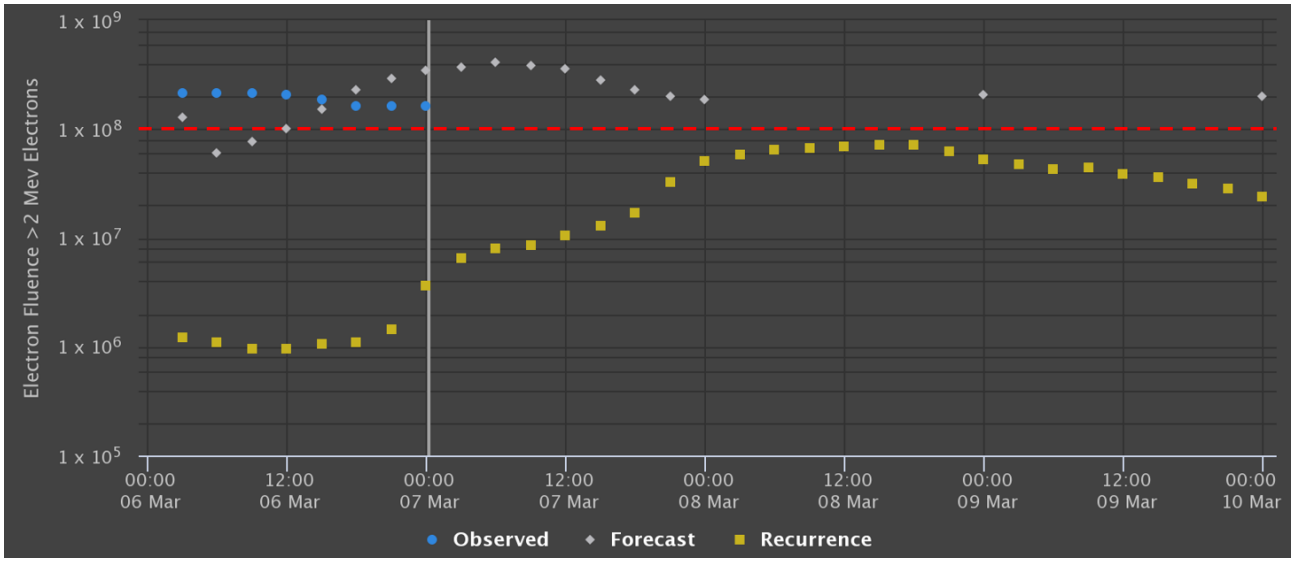
High Energy Electrons Event (≥ 2MeV):

Electron flux is at high levels due to recent inputs from the coronal hole high speed stream. This is likely to remain elevated above the high threshold through much of the period, in the absence of any enhancements to geomagnetic activity. There is a risk of an increase in electron levels as the belts are currently charged at levels below GEO. As the high speed stream from coronal hole 81 eases and the belts relax, the populations at lower orbits could enhance the GEO electron counts, although potential the connection of coronal hole 82 on 08 Mar could inhibit this relaxation.

Electron fluence is expected to remain above the Active (1e8 integrated pfu) threshold, with a very slight risk of exceeding the Very Active threshold, although with a slow downward trend later in the period.

GEO Electron Environment	Level ($cm^{-2}\,sr^{-1}\,day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	90	80	60
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	5	5	1	1

Figure 2: MOSWOC REFM



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